MUELLERIA

VOL. 2, No. 4. APRIL, 1973.

11734/72.

MUELLERIA

An Australian Journal of Botany

VOL. 2, No. 4. 9 APRIL, 1973

NATIONAL HERBARIUM
ROYAL BOTANIC GARDENS, MELBOURNE
VICTORIA, AUSTRALIA
D. M. CHURCHILL, Director and Government Botanist

11734/72.

CONTENTS

TWO NEW SPECIES OF ARCHIDIUM FROM VICTORIA, AUSTRALIA

by

ILMA G. STONE*

SUMMARY

Two new species, *Archidium stellatum* and *A. clavatum*, are described as the first authentic records of the genus for Victoria and the previously recorded sterile *A. stolonaceum* is shown to be an *Eccremidium* species. *A. stellatum* seems to be most closely related to some subjulaceous South American species and *A. clavatum* resembles the julaceous South American and South African species. Some developmental stages of the sporophyte are described for *A. stellatum*.

INTRODUCTION

Archidium, a genus of terrestrial mosses, the capsule of which is unique, has not previously been found fruiting in Victoria, and as the already recorded *Archidium stolonaceum* C. Muell. is not considered to be an *Archidium* (evidence for which will be given below) the species recorded in this paper are the first authentic records for Victoria.

An *Archidium* species bearing capsules was found in north central Victoria on 14 September 1968, in mallee country near Neilborough north of Bendigo and at Elphinstone south of Bendigo, and in the following month in the eastern Wimmera at Moyston. In March of the following year it was found at Mt. Tarrengower near Maldon, and at Sebastian and Raywood in July. Frequent visits were made to the location near Neilborough over a period of three years and the moss was observed at all stages of development.

This species, because of its variability in habit is difficult to place in either of the sections created by Mueller and used by Brotherus (1924). When growing in full sunlight it would be placed in the section *Sclerarchidium* because of the julaceous shoots, but in shade conditions this feature is not well-marked and it would be closer to the section *Euarchidium*.

A second species was found at Mt. Tarrengower on 1 February 1971, and another collection was made on 17 October 1971. From these small samples it would appear that this moss certainly belongs to the section *Sclerarchidium* for even though almost buried in a jelly-like mass of algae it still retains a strongly julaceous habit and appears closely related to *A. julicaule* C. Muell. from South Africa and *A. julaceum* C. Muell. from South America.

* Botany School, University of Melbourne.

11734/72.—2.

Descriptions of *Archidium species* are often incomplete and drawings in most cases do not give enough detail, but as far as can be determined from the type and other descriptions by Mueller (1882, 1888, 1899), Mitten (1887), Roth (1911, 1914), Britton (1913), Cain (1936), and others, and without actually examining the type specimens which I have been unable to obtain (unfortunately many of Mueller's specimens were destroyed at Berlin), the two Victorian species appear to be undescribed.

The genus is in need of revision on a world-wide basis, a task which it is understood is being undertaken by Mr. J. Snider of Duke University, North Carolina, U.S.A.

DESCRIPTIONS AND DIAGNOSES

Archidium stellatum I. G. Stone sp. nov.

ob cellulas foliorum parvas quadratas (usque ad breviter rectangulares) atque ob innovationes breves subjulaceas ex affinitate *A. arechavaletae* C. Muell., *A. amplexicaulis* C. Muell. et *A. gibertii* Mitt. (persimilis)—omnia ex America Australi; ab *A. arechavaletae* differt cellulis foliorum angustioribus paene regularibus (8–10 μ), nervo angustiore et foliis perichaetialibus anguste insertis; ab *A. gibertii* foliis multo latioribus (circa 0·4mm) atque ab *A. amplexicauli* in absentia nervi aurei excurrentis recedit; ab *A. amplexicauli* et *A. gibertii* ambobus in praesentia vittae latae cellularum laxarum pellucidarum (ad marginem basalem foliorum perichaetialium) atque innovationium (intra perichaetium emergentes) amplius distinguitur.

Holotype : Mallee country near Neilborough on bare light brown earth at roadside, *I. G. Stone 30*, 14.ix.1968, in Herb. MEL 1011755 ; Isotypes in Herbaria MELU and of the author.

Plants perennial, very small, cladautoecious, yellowish green, forming very low turfs about 3mm high on bare earth or scattered among other bryophytes and lichens.

Stems erect, simple at first with a terminal *Phascum*-like perichaetium, branching within the perichaetium by 1–7 (frequently 1–3) innovations (Plate 23B), usually one at the base of each of the innermost large perichaetial leaves, rarely just below the capsule (Fig. 55 a,c). *Innovations* short, erect, julaceous to subjulaceous, radiating to give a stellate appearance when the perichaetial leaves spread at maturity, eventually becoming fertile at the apex and repeating the

Fig. 55. *Archidium stellatum* sp. nov.

a. – Innovation and associated perichaetial leaf (abaxial surface); b. – branch from main stem, rhizoids near base; c. – young innovation with 2-celled hair at base; d. – innovation leaf (abaxial surface) at insertion with stem, margin torn and enrolled above tear; e. – the same, enlarged to show cell detail; f, g. – enlarged stem leaves from (*b*); f. – side view; g. – abaxial; h. – T. S. stem; i-m. – T.S. innovation leaves at various levels.

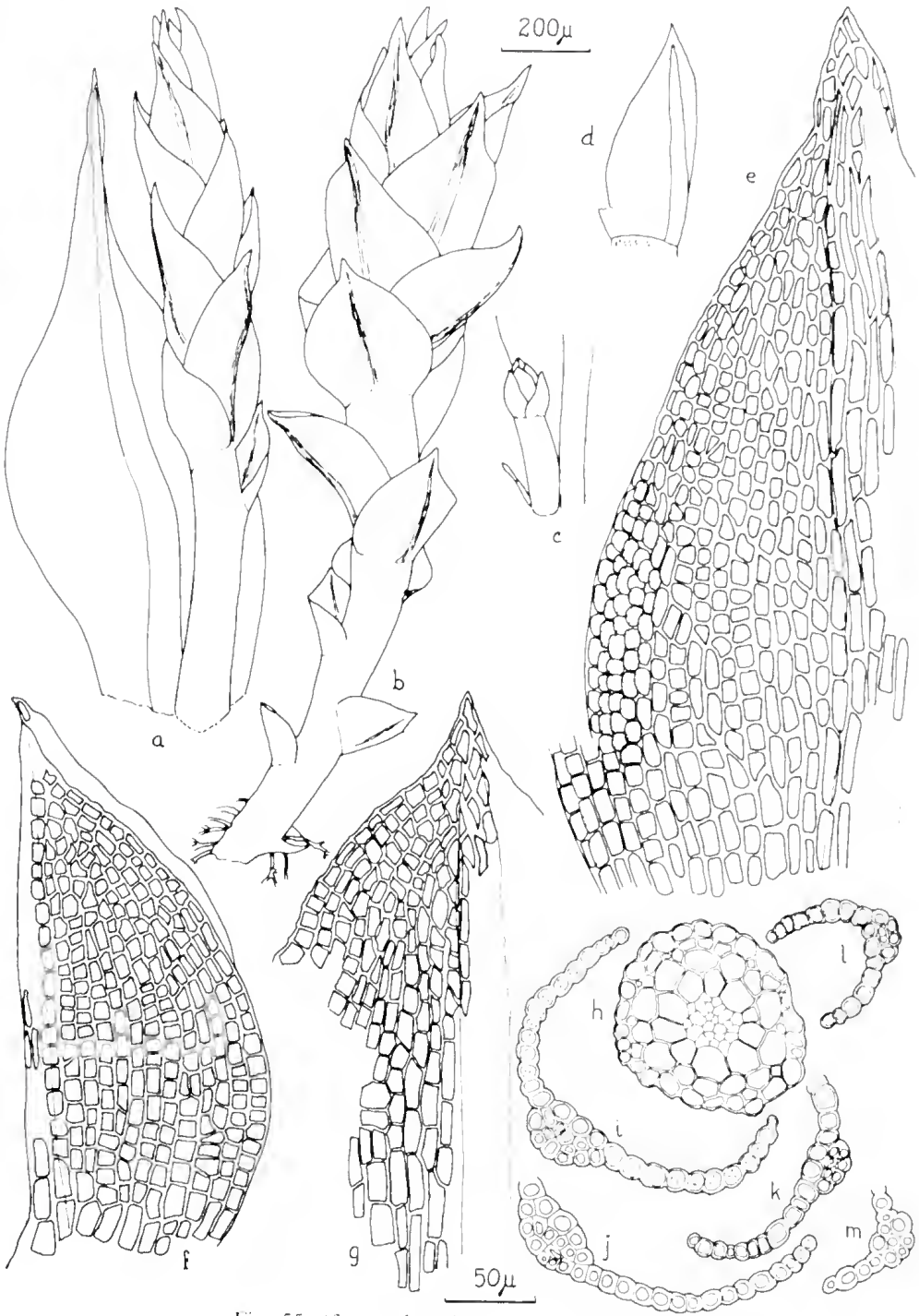


Fig. 55. (for explanation, see facing page)

branching system (like a pleiochasium) (Plate 23A,E), the basal parts gradually decaying. [When not growing in full light the subjulaceous habit may be lost and the innovations and branches are more attenuated with distantly spaced and more spreading leaves; plants reach 5–10 mm high (Plate 23C)]. *Lateral female or male branches* may arise later from the stem or innovations.

Stem and branch leaves close or distant, bract-like and less than 0·1mm long below, becoming larger upwards to 0 35 (0·5) mm long and closely overlapping below the perichaetium, sub-deltoid or broadly ovate, almost as wide as long, slightly apiculate, concave, wide at the insertion, more or less erect or sometimes with apex standing out from the stem, margin practically entire, nerve about 30 μ wide (40 μ at base) usually failing short of the apex or percurrent (Fig. 55b). *Cells* with firm walls, mostly quadrangular to very shortly rectangular (more oblique towards apex) about 8 μ wide, lower slightly wider 8 – 10 μ, ratio of length to width 1 – 2 : 1 (Fig. 55f,g). *Leaves of innovations* very concave, closely imbricated and appressed, more or less carinate above and with margins sometimes inrolled, mostly 0·5 mm long and 0·4 mm wide, similar in shape and areolation to stem and branch leaves but cells becoming more incrassate (Fig. 55a,d,e). Sections of innovation leaves and stem are illustrated in Figure 55h–m.

Perichaetial leaves 5–8, 1·0–1·5 (–1·9) mm long, 2·5 : 1, concave, occasionally secund but often spreading when capsule mature (Fig. 56f), ovate with a narrow insertion, widest just below the middle, suddenly narrowed to a short subula one quarter to one third the length of the leaf; *lamina* at the apex often slightly asymmetrical, in upper half of leaf slightly incurled to convolute and at the base with a broad marginal band of lax transparent cells extending to one quarter the length of the leaf (Fig. 56a); *margin* almost entire; *nerve* percurrent almost filling the subula (rarely slightly excurrent except by erosion) broad and flat below (Fig. 56a–e), strongest in mid-leaf, 90–100 μ wide narrowing to 30–40 μ in the subula (Fig. 56g–k); *lower cells* mostly rectangular firm-walled towards the nerve, becoming progressively narrower from the nerve to the marginal band of lax narrow cells, 15→12→10→8 μ wide, from 2–3 : 1→3–6 : 1; *cells of widest region*

Plate 23.—*Archidium stellatum* sp. nov
(Plants cleared and mounted in lactic acid)

A. Plant showing growth habit. Decayed capsule and perichaetial leaves of previous year, 3 mature capsules and 1 female head with undeveloped capsule. *I. G. Stone 139.* x ca. 19.

B. Plant with immature capsule and 3 innovations from within perichaetium. Holotype, *I. G. Stone 30.* x ca. 19.

C. Attenuated plant which had been covered by a twig. *I. G. Stone 2819.* x ca. 19.

D. Plant from compact turf mixed with *Bryum pachytheca* C. Muell. Note several growth increments and innovations from male branches (*m*). *I. G. Stone 292.* x ca. 8½.

E. Plant with branches from below the perichaetium as well as innovations from within; male branches. *I. G. Stone 1347.* x ca. 12.

PLATE 23

(for explanation, see facing page)

11734/72.—3

irregularly rectangular to rhomboidal with marginal row shortly rectangular, progressively narrower from nerve to margin as in lower part of leaf but becoming shorter towards the margin in the region above the lax alar cells, 5–6 : 1 → 4–6 : 1 → 3–4 : 1 (Fig. 56e) ; *cells of upper leaf* more regularly rhomboidal and developing thicker walls, 8–10 μ wide, 3 : 1, usually with a marginal row or two of short more or less rectangular paler cells, about 8 μ wide (Fig. 56d) ; cells of extreme apex inerassate, longer and narrower (Fig. 56b,c).

Capsules of the *Archidium* type, 1– several on a single plant, occasionally 2 to a perichaetium globose, 340 – 450 μ diam. immersed, sessile with a short thick foot in a cup-shaped vaginula. (Fig. 57j), cleistocarpous ; *exothecial cells* pale, often becoming dark brown to black and shining on top when capsule ripe and exposed (Fig. 57i, Plate 24C) ; *calyptra* small, fugaceous ; *spores* few, variable in number, usually in multiples of 4, 16–48, polyhedral, shortest dimension 100–120 μ, longest 140–150 μ, thick-walled, from almost smooth to finely sculptured, filled with yellow oil globules (Fig. 57k), mature September to November, but often persisting on the plant.

Antheridia 3–4, clavate, about 200 μ long, terminal, surrounded by 4–5 costate bracts on short or long slender lateral sparsely leaved branches (Fig. 57c, Plate 23DE) ; *perigonial bracts* entire, very concave, broadly ovate, apiculate, 250–400 μ long, *nerve* ending before the apex, more prominent on abaxial surface (Fig. 57f–h), sometimes slender innovations from between the perigonial leaves (Plate 23D).

Important features of *A. stellatum* are illlustrated in Figures 55–57 and Plate 23.

Specimens Examined :

Victoria—Mallee country near Neilborough on bare light brown earth at roadside, alt. c. 500 ft., mean ann. rainfall c. 18 in. *I. G. Stone* 30, 48, 14.ix.1968; *I. G. Stone* 139, 5.x.1968; *I. G. Stone* 174, 176, 12.x.1968; *I. G. Stone* 933, 8.iii.1969; *I. G. Stone* 1347, 14.vi.1969; *I. G. Stone* 1545, 20.vii.1969; *I. G. Stone* 2819, 20.ix.1970; *I. G. Stone* 2855, 14.xi.1970; *I. G. Stone* 2958, 16.vi.1971; *I. G. Stone* 7013, 25.vii.1971; *I. G. Stone* 7028, 7029, 7030, 17.x.1971; Elphinstone, on bare earth partly shaded by *Eucalyptus* sp., parking bay past 68 mile post, *I. G. Stone* 291, 292, 14.ix.1968; *I. G. Stone* 900, 8.iii.1969; *I. G. Stone* 1341, 26.iv.1969; *I. G. Stone* 1342, 14.vi.1969; Moyston on bare earth partly shaded by *Eucalyptus* sp., mean ann. rainfall c. 22 in., *I. G. Stone* 210, 19.x.1968; Serpentine road 4 miles west of Raywood on bare ground between scrub, mean ann. rainfall c. 17 in., *I. G. Stone* 1696, 20.vii.1969; Mount Tarrengower near Maldon, on bare gravelly soil partly shaded by *Eucalyptus goniocalyx* F. Muell. ex Miq., alt. c. 1,300 ft., mean ann. rainfall c. 22 in., *I. G. Stone* 987, 9.iii.1969 *I. G. Stone* 7031, 7032, 17.x.1971; *I. G. Stone* 7095, 15.i.1972; Mount Tarrengower, at the top 1872 ft., *I. G. Stone* 7089, 15.i.1972. (All specimens excepting holotype and an isotype in herb. author.)

Fig. 56. *Archidium stellatum* sp. nov.

a. – Perichaetial leaf, adaxial surface, marginal band of hyaline cells indicated; b, c. – apices of two perichaetial leaves, cell detail; d. – upper part of perichaetial leaf, below apex, cell detail; e. – base to mid-leaf between nerve and margin of (*a*) enlarged to show cell detail; f. – stem with perichaetium and capsule (innovations omitted); g-k. – T. S. perichaetial leaves at various levels; g. – upper part of leaf showing asymmetry; k. – near base of leaf.

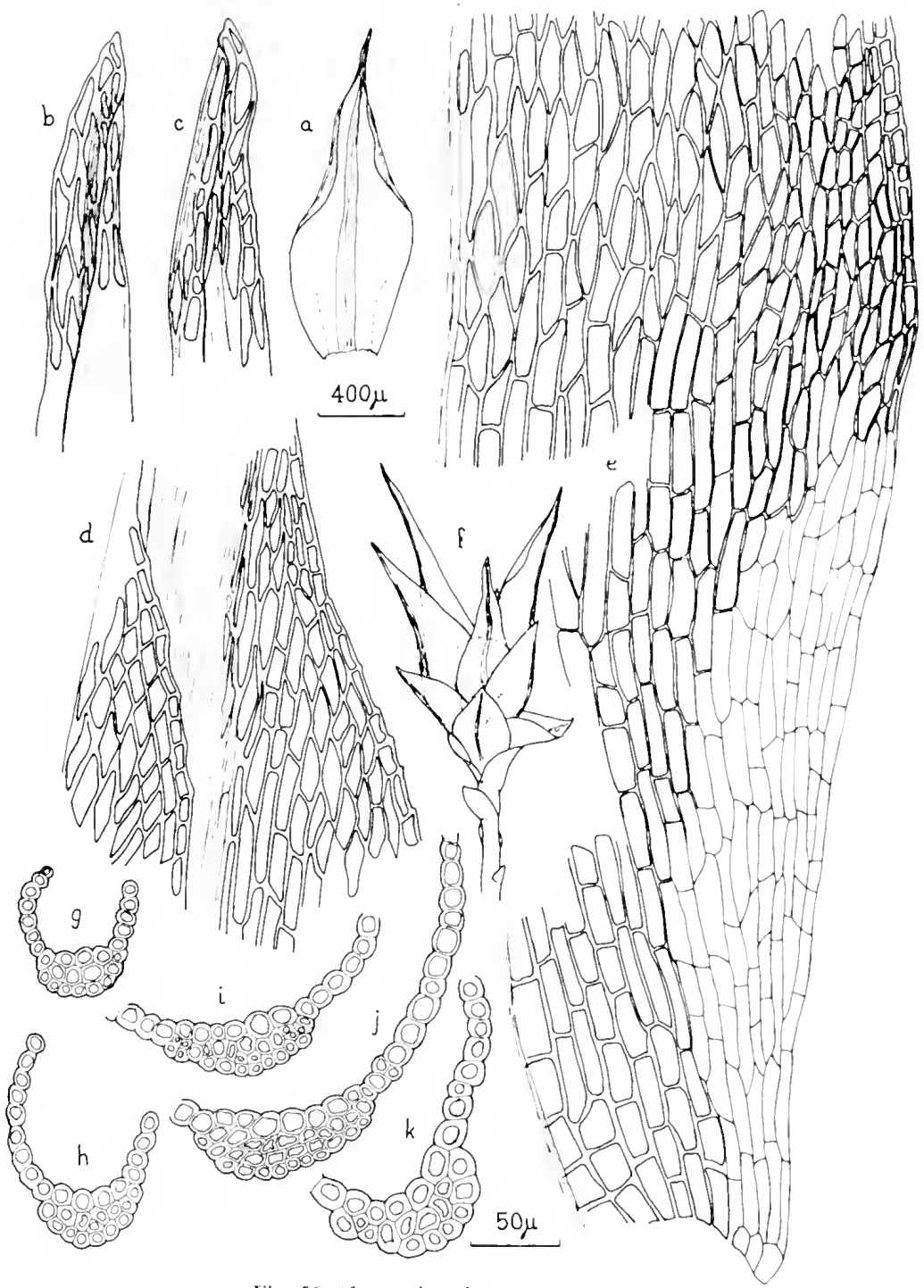


Fig. 56. (for explanation, see facing page)

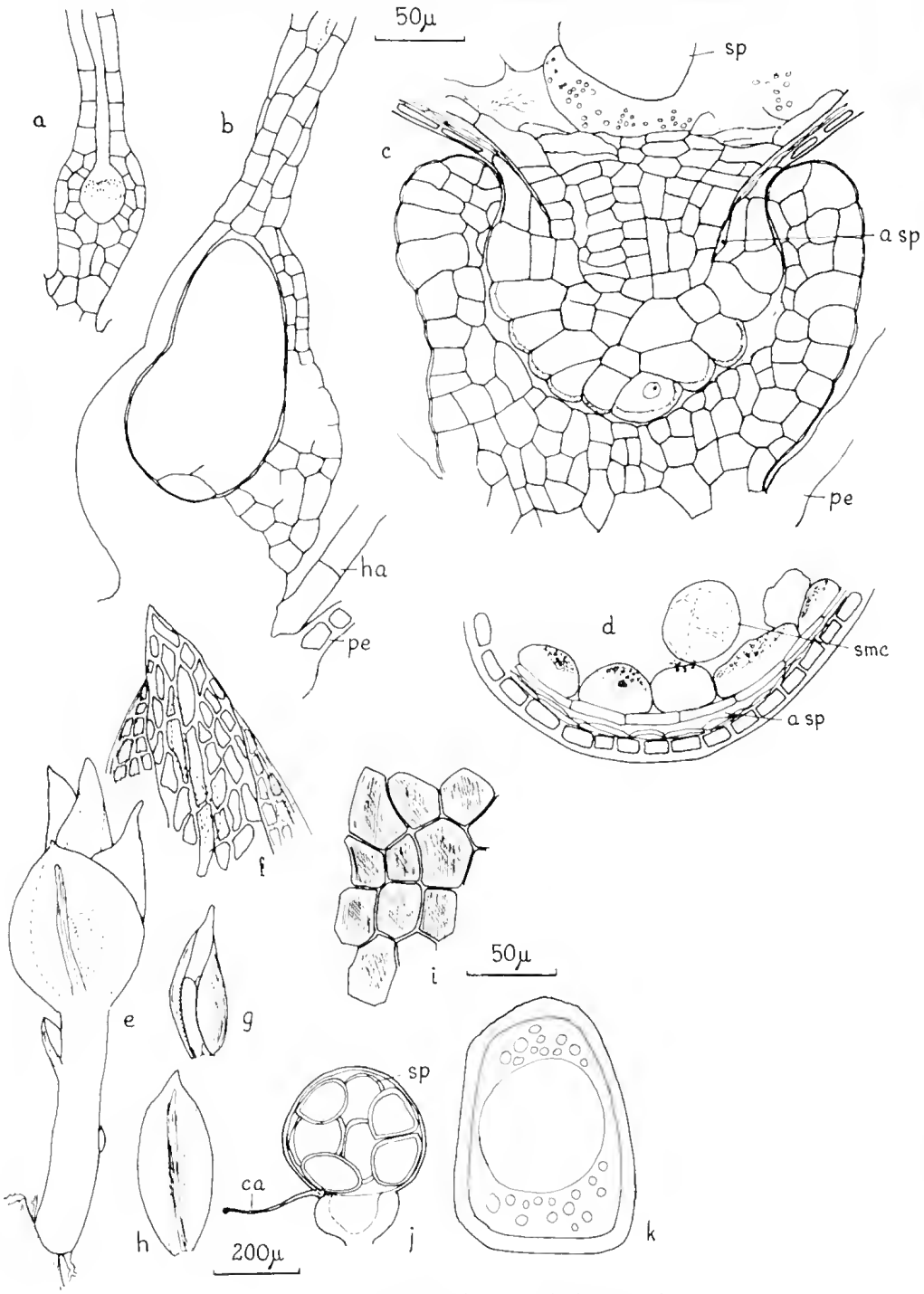


Fig. 57. (for explanation, see facing page)

Archidium stellatum which has small quadrangular to shortly rectangular leaf cells and short subjulaceous innovations appears closest to the South American species *A. arechavaletae* C. Muell., *A. amplexicaule* C. Muell. and the very similar *A. gibertii* Mitt. It differs from *A. arechavaletae* in the more regular and narrower leaf cells (8–10 μ), a narrower nerve and perichaetial leaves with a narrow insertion. It has much wider leaves (about 0·4 mm) than *A. gibertii* and lacks the golden excurrent nerve of the perichaetial leaves of *A. amplexicaule*.

Archidium clavatum I. G. Stone sp. nov.

ob cellulas foliorum parvas atque innovationes perjulaceas ut videtur *A. julaceum* C. Muell. ex America Australi et *A. julicaulem* C. Muell. ex Africa Australi proxime appropinquans; a priore habitu cladautoecio, foliis caulis latioribus et proportionibus cellulae differt; ab *A. julicaule* apicibus foliorum truncatis et marginibus eorum cristato-denticulatis recedit.

Holotype: Mount Tarrengower, near Maldon, on hard gravel in a depression in granitic rock and half buried in gelatinous algae, lichens and bryophytes, *I. G. Stone 7033*, 17. x. 1971, in Herb. MEL 1011756; Isotypes in Herbaria MELU and of the author.

Plants 3–5 mm high, cladautoecious, yellowish to brownish green. All plants so far found growing in the field were scattered and half-buried among gelatinous algae, lichens and bryophytes on hard gravelly detritus in depressions in granitic rock (Plate 25B).

Stems julaceous erect, usually arising from old buried stems or robust underground rhizoidal systems, with rhizoids at the base of stem and in leaf axils, simple at first with a terminal perichaetium of larger leaves, branching from between the upper long perichaetial leaves and the lower shorter ones by one or two short clavate strongly julaceous innovations which are bare at the base and usually with a characteristic bend just below the club-shaped apex (Fig. 58a, Plate 25A).

Stem leaves broadly ovate, concave, closely appressed and overlapping, nerve broadest at the base, finishing below the apex; *lower* leaves scale-like 150–200 μ long, wider than long, with ratio of length to width about 1 : 1·5, margin slightly crenulate-denticulate above,

Fig. 57. *Archidium stellatum* sp. nov.

a. – Optical section of archegonium (upper part of neck not shown), cleared in lactic acid; b. – optical section of young embryo in enlarged archegonium. *ha.* hair, *pe.* perichaetical leaf; c. – L. S. lower part of immature capsule, foot and vaginula; *sp.* immature spore, *a.sp.* air space; d. – T. S. immature capsule showing air space between capsule wall and spore sac, inner cells of spore sac with large nuclei, *smc*, spore mother cell at late telophase 2; e. – male branch with perigonial bracts enclosing antheridia; f. – tip of bract enlarged; g, h. – perigonial bracts; i. – dark exothecial cells from apex of capsule, surface view; j. – mature capsule with foot enclosed in vaginula. *sp*, spore, *ca*, calyptra; k. – spore with large and small oil globules, mounted in water.

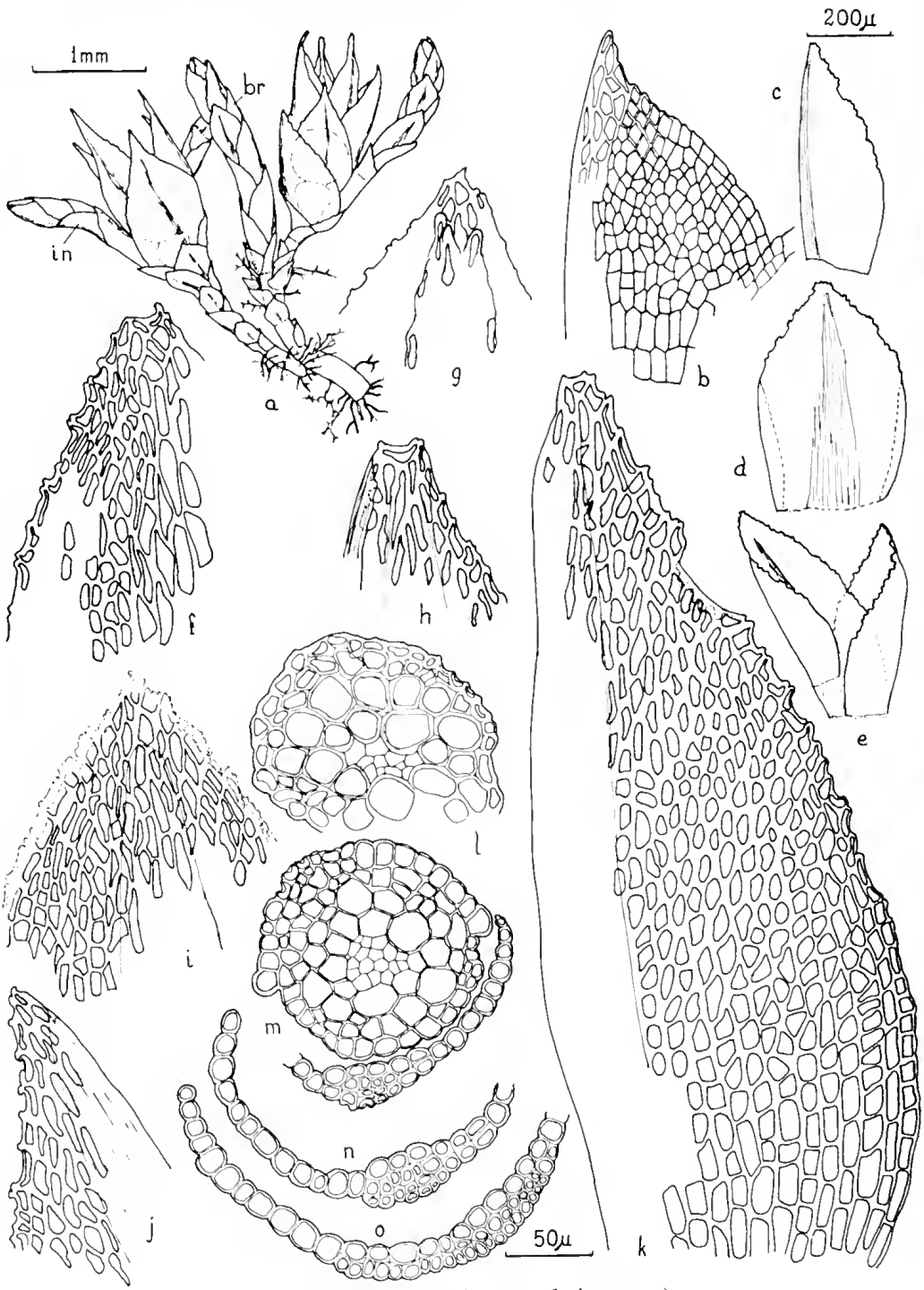


Fig. 58. (for explanation, see facing page)

cells below shortly rectangular about 9 μ wide, above shortly rhomboidal to 6-sided 10–12 μ long 7–8 μ wide (Fig. 58b) ; *upper leaves* to 400–500 μ long about 1·5–1, apex usually shortly apiculate upper margin eristate-denticulate. Cells below shortly rectangular 10–15 μ wide thin-walled but not lax, in mid-leaf 1–1·5 : 1, above firm-walled more or less rhomboidal 8–10 μ wide 2·5 : 1. *Leaves of innovations* closely imbricate and very appressed (Fig. 58a), ovate, very concave about 400–600 μ long usually less than 1·5 : 1 (Fig. 58e–e) ; *apex* obtuse either shortly pointed or truncate and sometimes almost cucullate (Fig. 58f–h) ; *margin* near the base more or less entire, above irregularly eristate-denticulate each denticulation formed from two cells, eroding with age (Fig. 58i–k) ; *nerve* wide, broadest at the base 60–90 (–150) μ and flat (2–3 cells thick) reducing to about 30–50 μ wide (Fig. 58d, m–o) and ending shortly below the apex, occasionally with some projecting cells in this region on the abaxial surface (Fig. 58g) ; *cells* below shortly rectangular with very firm walls about 10–12 (–15) μ wide 1–3 : 1, above becoming oblique and slightly narrower about 8 μ mostly 2 : 1, inerassate, the lumen variable in shape, often with rounded corners but the basic cell pattern is rhomboidal, marginal cells sometimes only 5–6 μ wide (Fig. 58k).

Perichaetial leaves 7–9, more or less in 3 whorls of approximately equal leaves, the lowest the shortest about 0·6–0·75 mm (Fig. 60a,d), the middle about 0·8–1·1 mm (Fig. 60c), and the upper about 1·3–1·5 (–1·7) mm (Figs. 59a, 60b), ovate about 1·5 : 1, tapering suddenly to the apex which is frequently obtuse or truncate (Fig. 60jk), innermost leaf often convolute ; *lamina* at the base with a marginal band of lax transparent cells extending to one third the length of the leaf and near the apex often incurled giving the appearance of a short subula ; *margin* entire below but irregularly eristate-denticulate above the basal marginal band [the denticulations are formed by the outward projection of the outer distal end of a marginal cell and usually a similar projection from the outer proximal end of the cell immediately above, the pairs of projections usually being fused for most of their length and the free projecting tips sometimes curled inwards ; usually 2 cells are involved in a denticulation but occasionally 3–4 or only one (Fig. 60m,n)] ; *nerve* flat below about 60–100 μ stronger in mid-leaf and narrowing to about 50 μ or less but still strong, where it ends just below the apex. Erosion of the leaf is common leaving the strong nerve apparently excurrent. *Cells* at the insertion of the largest perichaetial leaves, 1–3 rows, large quadrate to shortly rectangular, above

Fig. 58. *Archidium clavatum* sp. nov.

a. – Habit. *in*, innovation, *br*, branch; b. – lower stem leaf showing cell detail; c-e, innovation leaves; c. – side view; d. – abaxial showing very broad nerve; e. – attached to portion of stem; f-j. – tips of innovation leaves; g. – abaxial showing projecting cells or nerve; i. – eroded margin; j. – side view; k. – enlargement of (c) showing cell detail; l. – T. S. stem; m. – T. S. innovation stem showing a leaf base, and leaf cut in upper part; n,o. – T. S. innovation leaves; n. – mid-leaf; o. – base, showing very broad nerve part of which is only two cells thick.

which they are more or less rectangular, firm-walled except near the margin, becoming progressively narrower from the nerve to the marginal band of lax narrow cells 20 (25) → 12–15 → 10 μ wide, the ratio of length to width increasing from 3–4 : 1 → 4–5 : 1 → 8–9 : 1 ; *cells in the upper part* of lower third of leaf more oblique, irregularly rhomboidal, narrower and prosenchymatic near nerve 5–7 : 1 → 3–4 : 1 → 5–6 : 1 (marginal band) ; *cells of widest region* and just above gradually becoming shorter and more regularly rhomboidal (often appearing slightly flexuous) mostly 3–4 : 1 except near nerve and often with an intramarginal band of narrow rectangular cells ; *cells of the upper leaf* more regularly rhomboidal, 10–12 → 5–8 μ and 2–3 : 1, but at the very apex again becoming more irregular in shape and often very incrassate (areolation of a large perichaetial leaf is illustrated in Figures 59a–d and 60l) ; *cells of the lowest perichaetial leaves* with walls thinner than those of the upper which are with firm-walled.

Capsules of the *Archidium* type, about 550 μ diameter (Fig. 60f), outer walls of *exothecial cells* very thick (Fig. 60g,h) ; *calyptra* small, fugaceous ; *spores* polyhedral 130 μ in shortest dimension about 160 μ in longest dimension, finely but distinctly granular (Fig. 60i).

Antheridia 3–4, clavate, about 200–300 μ long terminal on a short julaceous shoot arising from a buried stem (Fig. 60e) ; *lower scale-like leaves* closely appressed and imbricate, rounded to shortly apiculate at apex, without a nerve ; *perigonial bracts* with a very narrow flat nerve finishing below the apex, convolute and often truncate at the apex.

Important features of *Archidium clavatum* are illustrated in Figures 58–60 and Plate 25.

Specimens Examined :

Victoria—Mount Tarrengower, near Maldon, on hard gravel in a depression in granitic rock and half buried in gelatinous algae, lichens and bryophytes, alt. c. 1,400 ft., mean ann. rainfall c. 22 in., *I. G. Stone* 2912, 1.ii.1971 ; *I. G. Stone* 7033, 17.x.1971; *I. G. Stone* 7088, 15.i.1972. (All specimens in Herb author, excepting holotype and an isotype.)

PLATE 24.—*Archidium stellatum* sp. nov.

Photographs in the field showing variation in appearance according to age and density of the plants and to environmental conditions. Arrows indicate capsules. All x ca 12.

A. Fertile plants with immature capsules still enclosed by perichaetial leaves. Innovations from between perichaetial leaves. Dense turf in slight depression with partial shade from small bush. *I. G. Stone 7028.*

B. Scattered plants with mature capsules, two detached lying on ground. On higher ground in more exposed position than A. *I. G. Stone 7029.*

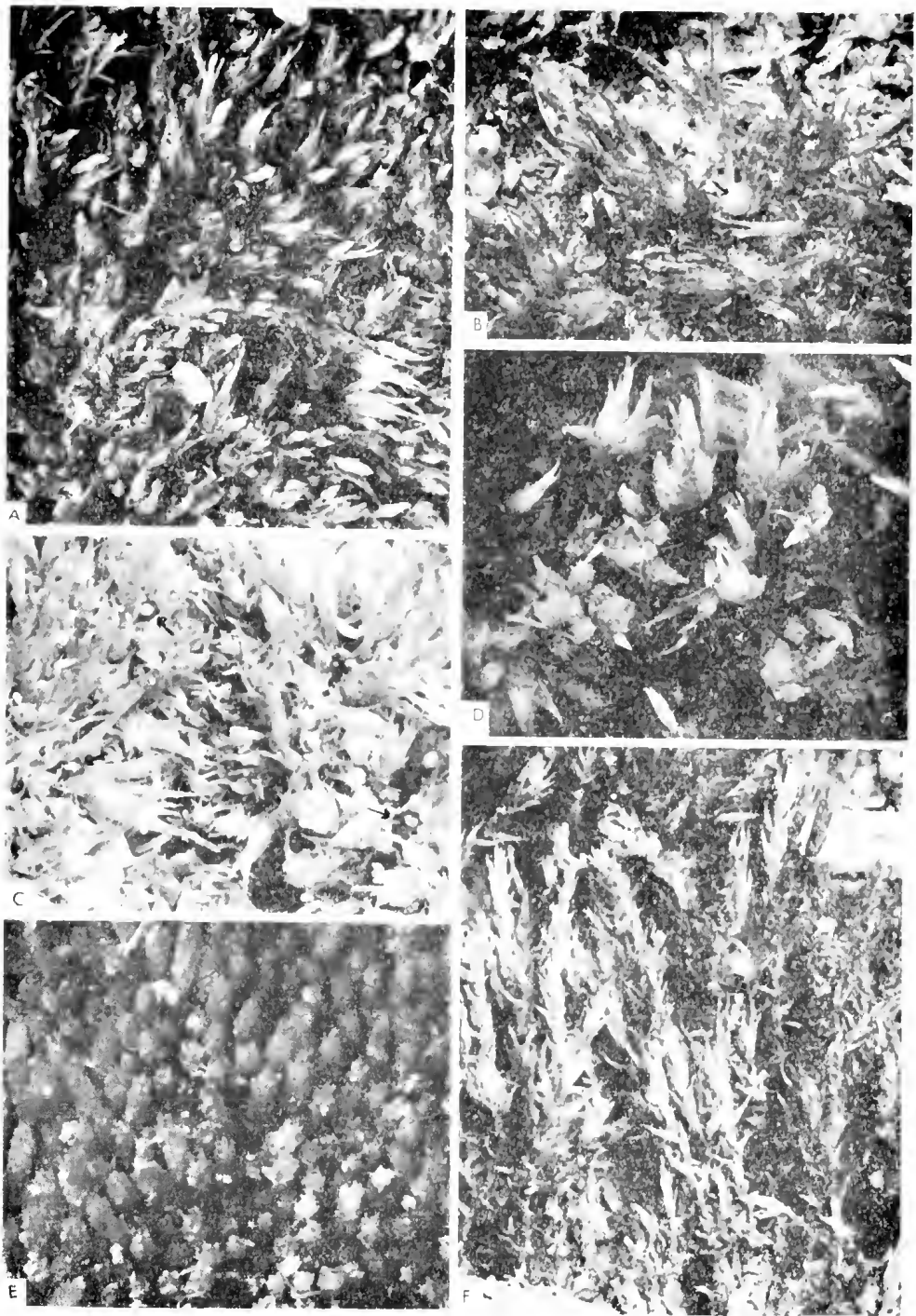
C. Dense turf, mature capsules black and shining on top show between spreading perichaetial leaves. *I. G. Stone 7031.*

D. Plants scattered among other bryophytes and lichens. *I. G. Stone 176.*

E. Dense turf of innovations (wet). Old decayed capsules are hidden below. *I. G. Stone 7032.*

F. Elongated plants sheltered by a twig. The innovations are longer and the leaves slightly more distant and spreading but the plants still show essentially the same pattern of growth and areolation. *I. G. Stone 7030.*

PLATE 24



(for explanation, see facing page)

Archidium clavatum which has small leaf cells and strongly julaceous innovations appears closest to the South American *A. julaceum* C. Muell. but differs from this in its cladautoceious habit, broader stem leaves (not lingulate) with narrower cells (8–10 μ below, 7–8 above) ; or to the South African *A. julicaule* C. Muell., from which it differs in the truncate apices and cristate-denticulate margins of the leaves.

SOME OBSERVATIONS ON THE SPOROPHYTE

Some developmental stages of the sporophyte were observed mainly in *A. stellatum*. In both species only 3–4 archegonia were formed to each perichaetium, accompanied by a few inconspicuous 2–3-celled hairs. Similar hairs were sometimes associated with antheridia or young innovations (Fig. 55e). The archegonia have long necks and a small stalk region (Fig. 57a). After fertilization there is some enlargement of the stem apex, but the small cup-shaped vaginula is formed by division and enlargement of the archegonial stalk cells and possibly the venter cells below the zygote (Fig. 57b,e). The foot of the embryo is very shallow and does not penetrate beyond the archegonial tissue into the gametophore apex as occurs in most mosses (Fig. 57e). The venter cells on either side of the zygote elongate but there are very few if any divisions and the young developing embryo causes the calyptra to rupture off as a fugaceous remnant consisting of the torn venter cells and the shrivelled neck attached to the vaginula on one side (Fig. 57j).

After fertilization the capsule is slow in its development, the calyptra does not protect it for long and this function is provided by the large perichaetial leaves. As the moss grows in areas with low and unreliable rainfall, development is frequently arrested and the capsule aborts. Thus the sequence of development of the sporophyte is not easy to follow and some critical stages including the precise mode of formation of the variable number of spore mother cells have not been observed.

Early in development, a narrow dome-shaped air space forms between the outer capsule wall which consists mostly of three layers and the central sporogenous region (enclosed in a 2-layered spore-sac) and extends downwards around the sterile region below the sporogenous tissue (Fig. 57c). The cells of this sterile region adjoining the air space appear to have slightly cutinized walls.

The absorbing cells of the shallow broad foot are like those of *Mittenia plumula* (Mitt.) Lindb. (Stone 1961) and many other mosses, bulbous, densely cytoplasmic with large nuclei and a thick translucent lining layer on the outer walls in contact with the gametophyte. The capsule is very easily dislodged from the vaginula because of the shallow foot.

Fig. 59. *Archidium clavatum* sp. nov.

a. – Perichaetical leaf with marginal band indicated. Regions 1, 2, 3, 4 enlarged in Fig. 60l, and Fig 59, b-d. b. – cell detail of (*a*) region 2; c. – cell detail of (*a*) region 3; d. – cell detail of (*a*) region 4.

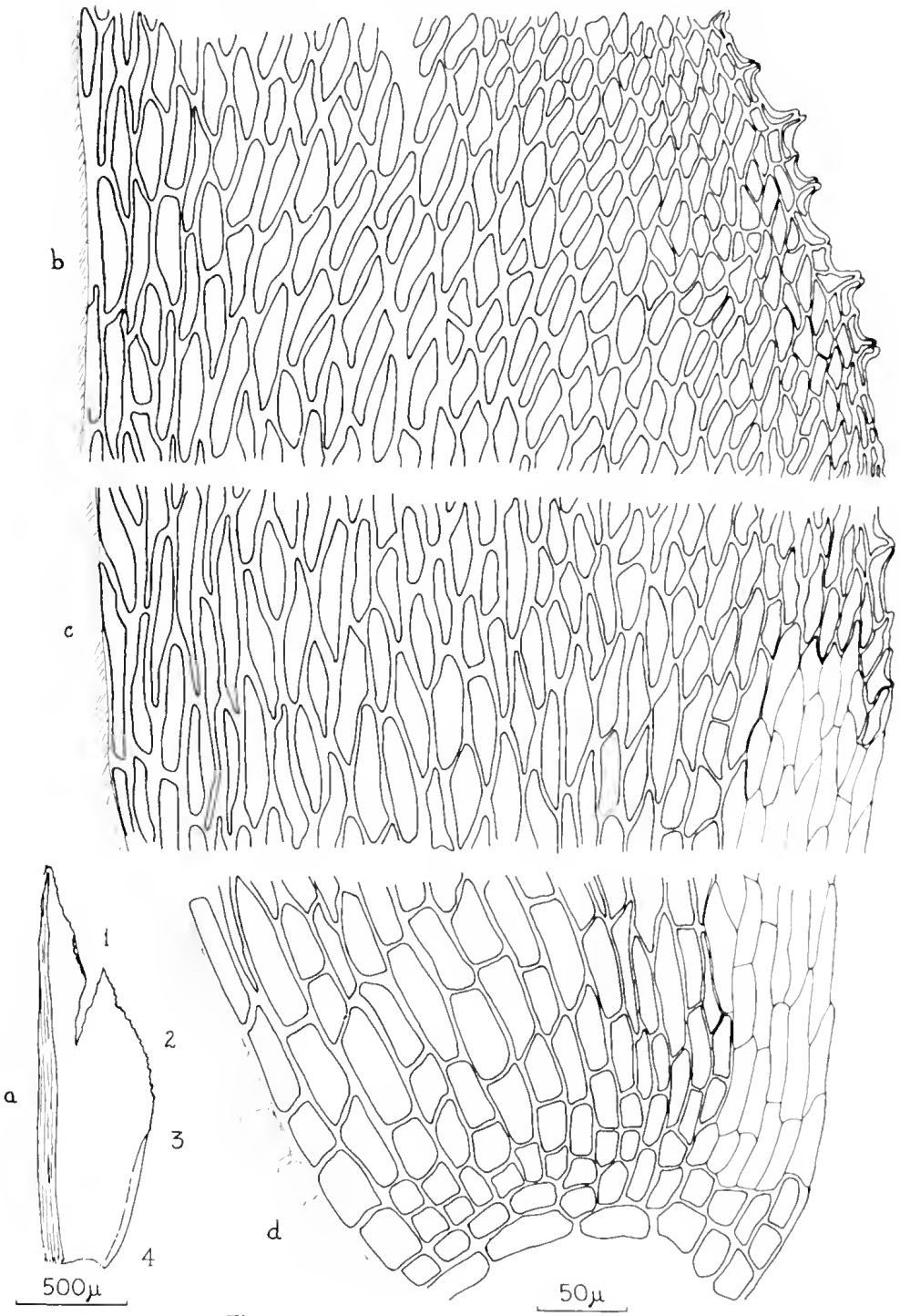


Fig. 59. (for explanation, see facing page)

Sections of the immature capsules of *A. stellatum* show that the spore sac consists of two layers of large cells, the outer of flat cells, the inner of inflated cells each with a large nucleus. Associated with this nucleus is densely staining material (lactophenol cotton blue) on the inner surface of the side adjoining the spore mother cells (Fig. 57d). The inner layer is continuous over the sterile cells at the base of the theca so that it completely lines the thecal cavity and surrounds the spore mother cells. Later the inner surface of these cells adjacent to the young tetrads has a granular appearance; the granules which are yellowish and highly refractive resemble the " Ubisch " bodies described for Angiosperms. [These cells bear a striking resemblance to the tapetal cells of *Magnolia youlan* and *Lilium tigrinum* figured by Maheshwari (1950) in which the granular markings give the same staining reactions as the coat of the pollen grain.]

At the stage when the spores have a thin exine and are free in the thecal cavity the lining layer appears collapsed and covered with aggregations of granules, many of which also appear around the spores (Fig. 57c).

As far as can be determined with the light microscope, the development of the cells lining the thecal cavity and the granular material appear to be very similar to the development of the tapetum and the " Ubisch " bodies in the anther of *Helleborus foetidus* L. described by Echlin and Godwin (1968).

As no granular material was observed in the spore sac of *Mittenia plumula* (Stone 1961) it seems likely that just as in Angiosperms (Davis 1966) there may be some mosses with " Ubisch " granules and others without.

After many attempts to find cells at a suitable stage to obtain a chromosome count, Anaphase 1 of meiosis was observed in a few spore mother cells of *A. stellatum* and a count of 13 was made at each end of one cell in which the chromosomes were reasonably well spread.

Unlike most mosses *Archidium* does not produce many spore mother cells and their number is variable but in *A. stellatum* there were frequently 12, resulting in 48 spores, a number larger than usually reported for the genus. Few capsules of *A. clavatum* have been examined but 32 mature spores and several small aborted spores were observed in one capsule. Immature spores of *A. stellatum* had very thin walls (the thick intine was not developed) and contained small chloroplasts, large vacuoles in the cytoplasm and one large and many small oil globules.

Fig. 60. *Archidium clavatum* sp. nov.

a. – lower perichaetical leaves and upper stem leaves overlapping; b, c, d. – perichaetial leaves from inner whorl outwards; b. – inner convolute; c. – leaf of second whorl; d. – leaf below innovation; e. – julaceous male branch with antheridia enclosed in perigonial bracts; f. – capsule with large spores and small foot; g. – l., S. wall of capsule; h. – surface view of exothecial cells from top of capsule (dark coloured); i. – spore mounted in lactic acid, outer layer of spore ruptured; j, k. – tips of perichaetial leaves showing cell detail; l. – cell detail of Fig. 59a, region 1; m, n. – margin of (*d*) enlarged.

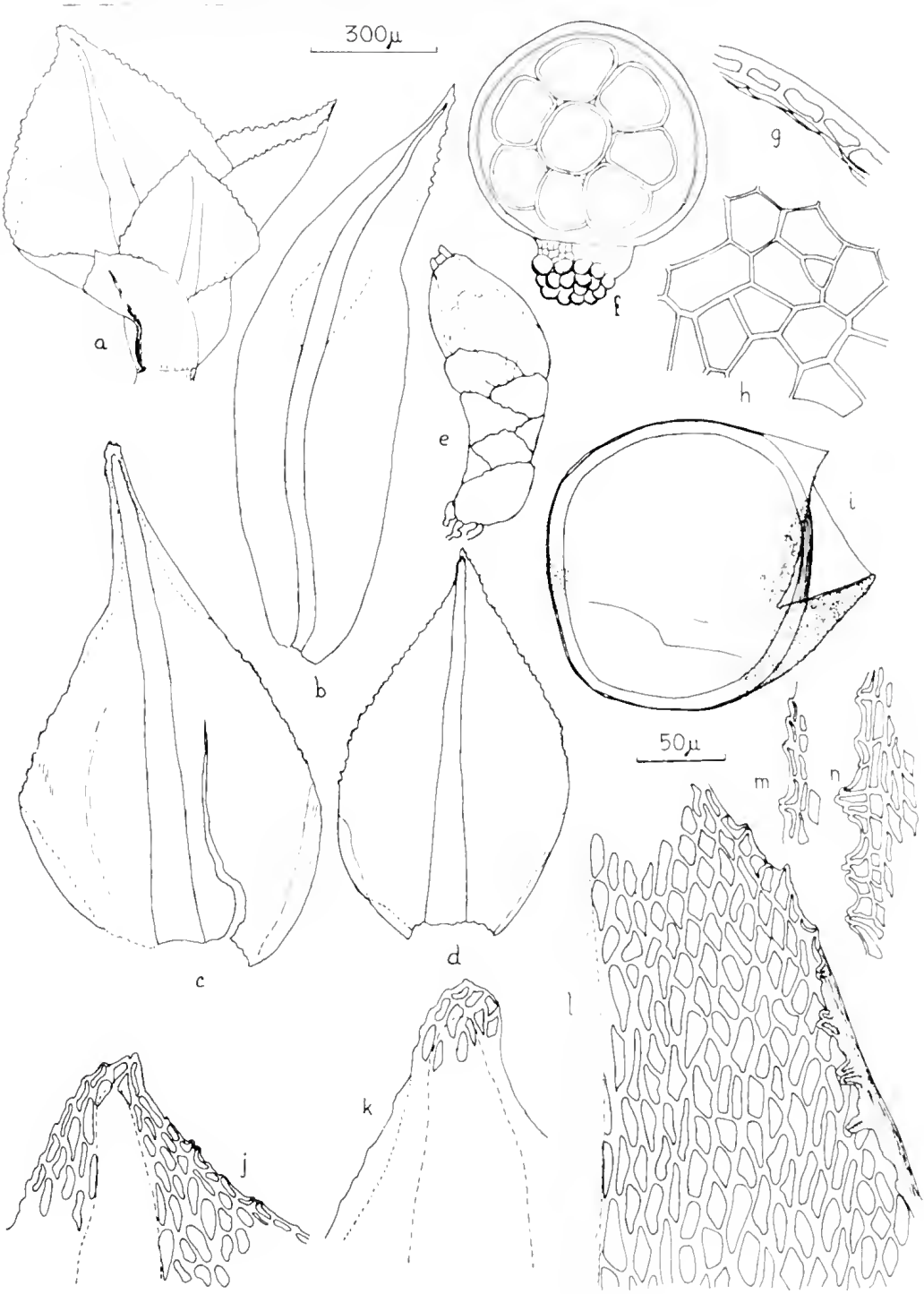


Fig. 60. (for explanation, see facing page)

Mature spores when heated in lactic acid showed some details of the spore coat. The thin outer layer of exine which bore the fine granular ornamentation could be ruptured off (more readily in *A. clavatum* than in *A. stellatum*) and the inner thick layer of intine (about 10 μ thick in *A. clavatum*) had a well-defined laminated structure (Fig. 60i). When the spore coat was broken by pressure on the spore this thick layer frayed at the broken edges giving indications of the fibrillar nature of the intine. McClymont and Larson (1964) made an electron-microscopic study of thin sections of the spore wall of several mosses including *A. alternifolium* Schimp., and for the latter reported the unusually thick laminated intine, the exine with ornamentation and a very thin outer layer of perine. Although they reported four layers to the spore coat for most species they did not effectively demonstrate this in *A. alternifolium*.

Spores of *A. clavatum* stained with Sudan IV showed a very narrow and closely adherent layer on the outside of the intine (stained red so presumably exine) as well as the thin ornamented exine layer which separates off. This layer, just external to the intine, possibly corresponds to the electron opaque layer described by McClymont and Larson for most of the moss spores they examined, but it appears to be wider in *A. clavatum*. Heslop-Harrison (1968) in his study of the wall of *Lilium* pollen shows the inner unsculptured part of the exine divided into an inner layer (the nexine 2) closely applied to the intine and separated by a discontinuity from an outer layer (nexine 1). Larson and Lewis (1961) using both optical and electron microscopy described a 2-layered exine for pollen of *Parkinsonia aculeata*, an inner layer adjacent to the intine and an outer layer bearing the ornamentation with a structural weakness at the interface of the two layers. The discontinuity and structural weakness described by these authors seems to be in a position corresponding with the line of separation of the sculptured exine in *A. clavatum*.

At maturity the exothecial cells have a thick outer wall (especially in *A. clavatum*) covered by a very thin shining cuticle (Fig. 60g). In both species the cells of the exothecium on the top of the capsule develop a brown to blackish colour when mature and exposed (Figs. 57i, 60h), constrasting with the pale wall of the rest of the capsule. The two inner layers of the capsule wall are flattened at an early stage so that the mature capsule wall appears to be of one layer (Fig. 57d), the air space is obliterated and the very large thin-walled cells of the spore sac may be pulled away as a membrane when the mature capsule is opened.

No stomata are formed but at the base of the theca in some mature capsules a few fissures, which possibly represent the beginning of distintegration of the capsule, were observed between the outer exothecial cells just above the cells of the foot opposite the base of the airspace. The exothecial wall is usually thinner in this region.

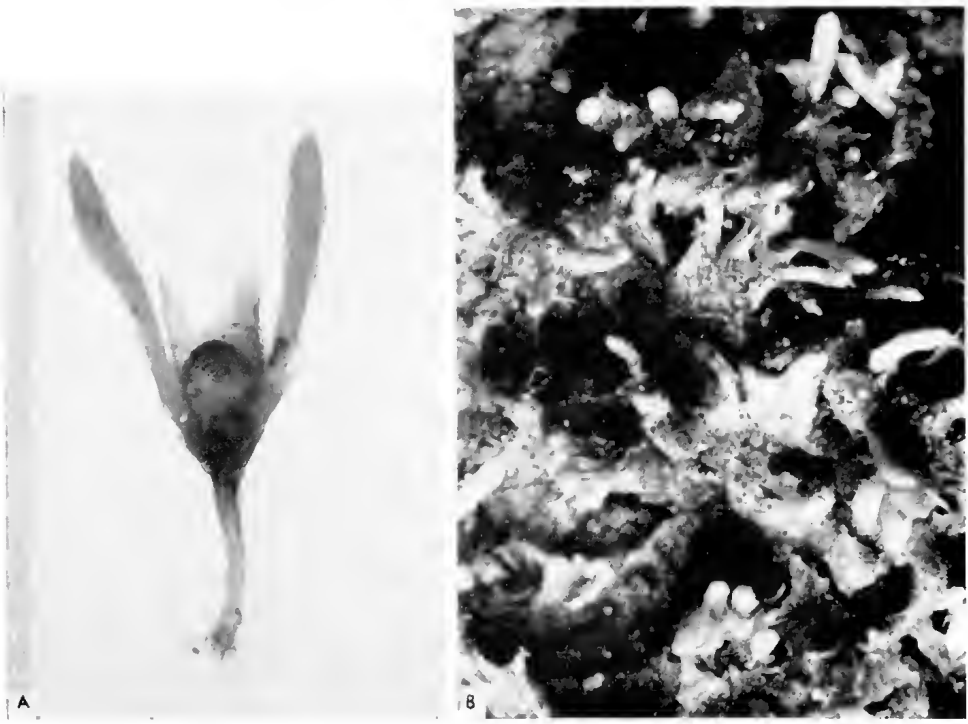
Old capsules may persist on the plant from one year to the next and finally decay so that the spores lie in small yellow masses, or the

capsules are dislodged and lie loose on the ground before decaying (Plate 24B). The yellow colour of the spores is mainly from the oil which is also abundant in other parts of the plant including cortical cells of the stem, leaf cells, large rhizoids and foot cells.

The genus *Archidium* has a unique sporophyte in which a columella does not penetrate through the spore-bearing region and there is no evidence of an apiculus on the globose capsule as an apical cell is active at the apex of the young embryo for only a few divisions before a periclinal wall is produced. A dome-shaped air space forms between the capsule wall and the spore sac which encloses the central sporogenous region in which only a few spore mother cells are formed and the ripe capsule is filled with a few very large spores which have an unusually thick laminated intine.

The genus has been considered primitive by some bryologists, greatly reduced by others and is usually placed in the order *Dicranales*.

PLATE 25



Archidium clavatum sp. nov.

A. Single plant with mature capsule and 2 innovations. Cleared and mounted in lactic acid. Holotype, *I. G. Stone 7033*, x ca 19.

B. Habit in the field (liverworts have been removed leaving holes). Only the tips of the perichaetial leaves and the innovations show above the gelatinous algae. Holotype, *I. G. Stone 7033*, x ca 12.

The distinctive features of the sporophyte appear as unique as those of *Sphagnum* and *Andreaea* and could easily warrant a position in the classification at the level accorded to these genera.

HABIT

Archidium stellatum appears to be a soil colonizer and well suited in its manner of growth to a habitat where there is a tendency for the sand and clay particles to wash during periods of rain and build up around the plants and often only the innovations, tips of perichaetial leaves and tops of capsules show above the soil level. During long dry periods the surface of the soil sets very firmly. The growth habit with seasonal increments by repeated acrotonic innovations is illustrated in Plate 23.

The general appearance of the perennial gametophyte in the field varies according to the stage in the growth sequence, the density of the plants and environmental conditions. It is inconspicuous and non-descript and would be easily overlooked or mistaken because of its general resemblance to other more common mosses and no doubt it is much more widely spread than is indicated by the localities recorded in this paper.

Variability in appearance is illustrated by photographs of plants in situ (Plate 24).

Archidium clavatum was found on gravelly detritus in a shallow depression in granite rock where water lies after rain but which is very dry for long periods. Scattered plants were first found in the summer and most of the leaves were considerably eroded leaving the nerve projecting. Mature and old capsules were present but no archegonia or antheridia were observed.

Another collection was made from the same area in the following spring, after new growth and young capsules surrounded by intact perichaetial leaves had formed. Innovations were young and the cristate-denticulate margins of the leaves were not eroded as in the summer collection. The plants were scattered and difficult to find because they were buried to part way up the perichaetial leaves in a jelly-like mass of algae, and mixed with various lichens, hepatics and other mosses. Male branches were rare and buried in the algal mass. Plate 25B is a photograph of *A. clavatum* in situ but with some hepatics removed, leaving holes.

Most of the plants were growing from pieces of partly decayed and buried stems and it is possible that this moss is also a colonizer but it was found after invasion and replacement by other bryophytes etc. and would have been more plentiful a few years earlier.

DISCUSSION

Two species of *Archidium* have previously been recorded for Australia; *A. stoloniaceum* C. Muell., from New South Wales and

Victoria, and *A. rothii* Watts ex Roth from Queensland. [A third species *A. brisbanicum* Broth. was also described but Brotherus (1893, 1924) later changed his determination to *Nanomitrium*.]

The type material of *A. stolonaceum* was collected by T. Whitelegge at Paddington, Sydney in November 1884 and was described by Mueller in 1888. A few more collections, including that used by Roth (1911) for his figures and description, were subsequently gathered in the Sydney area. Clifford and Willis (1951) recorded *A. stolonaceum* from Castlemaine, in Victoria. This specimen was collected by Mr. F. Robbins in 1948 and determined by G. O. K. Sainsbury.

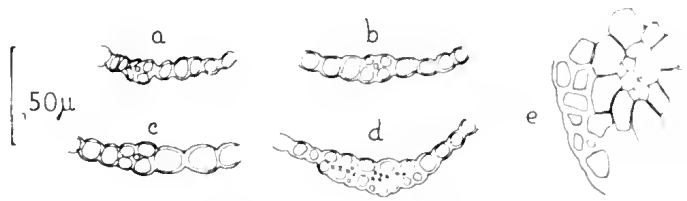


Fig. 61.—a.–T. S. leaf nerve of *Archidium stolonaceum* (from *T. Whitelegge 211*, Paddington, N.S.W. 1884, part of type, Hb. MEL); b. T. S. leaf nerve of fertile *Eccremidium pulchellum* (from Western Australia); c. T. S. leaf nerve of sterile *Eccremidium* sp. (from near Neilborough, Vic.); d.–T. S. leaf nerve of *Pleuridium nervosum* (from near Neilborough, Vic.); e.–T. S. stem from small shoot of type of *Archidium stolonaceum*.

All samples, including part of the type specimens from the Melbourne and Sydney herbaria, have been carefully examined. No capsules were present and the descriptions made by Mueller (1888) and Roth (1911) were from sterile material. I consider that this moss is not an *Archidium* but a sterile *Eccremidium* sp. [probably close to or identical with *E. pulchellum* (Hook. f. and Wils.) Wils.] which is common in all Australian states and bears gemmaceous branchlets like those in the samples of Mueller's type of *A. stolonaceum*. This moss has given considerable trouble in identification in several instances. Further investigation of the genus *Eccremidium* is in progress and a fuller account will be published later.

Convincing evidence was obtained from the anatomical structure of the nerves observed in leaf sections. The structure of the nerve of Mueller's type (Fig. 61a) is similar to that found in *E. pulchellum* and the sterile *Eccremidium* (Figs. 61b,c) but entirely different from that of the genus *Archidium* (Figs. 55i–m, 58m–o). In Victoria, the vegetative shoots of *A. stellatum* and *A. clavatum* at first sight could be easily mistaken for other commoner mosses such as the sterile *Eccremidium* sp. or *Pleuridium nervosum* (Hook.) Mitt. which have a julaceous habit and often grow closely intermixed with them, but sections of the leaf nerve would dispel all doubts in each case. Illustrations of leaf sections demonstrate the different structure of the nerve in *Pleuridium nervosum*, *E. pulchellum* (a fertile specimen from Western

Australia), sterile *E. ? pulchellum* from Victoria and the two new *Archidium* species from Victoria (Figs. 55i–m, 58m–o and 61b–d). Both *Pleuridium* and *Archidium* have a comparatively broad nerve but *Pleuridium* has an irregular distribution of small thick-walled stereid cells while *Archidium* has no stereids but the cells of the nerve are evenly thickened. *Eccremidium pulchellum* and the sterile form both have a narrow nerve with a pair of cells each with a large lumen on both the upper and lower surface enclosing one or two small central cells.

A comparison of the anatomical structure of the stems provides further evidence in support of the view that Mueller's *A. stolonaceum* is in fact a sterile *E. pulchellum*. In *Archidium* the thin-walled cells of the central strand are surrounded by large cortical cells and smaller peripheral cells all more or less evenly thickened (Figs. 55h, 58l,m). In *Eccremidium* the two outermost layers of the stem are more heavily thickened than the inner cortical cells and this heavy thickening was found in the type specimen of *A. stolonaceum* (Fig. 61e).

The only other record of an *Archidium* species in Australia is *A. rothii* which was named but not described, as far as I can determine, by W. Watts from the Brisbane area. Roth (1914) described and figured *A. rothii* using Watt's specimen from the Brisbane Herbarium. Spores were not seen. A search was made in the Brisbane and Sydney herbaria for the type or any other material of this species without success. However Roth's description does not fit the Victorian species. *Archidium rothii* is described as having vegetative leaves with entire margins and a very prominent mid-rib excurrent in a long point, and the male ' inflorescence ' with ecostate bracts borne on the fruiting stem.

During an examination of the *Archidium* specimens in the National Herbarium, Melbourne, it was noted that two of Dr. A. Rehmann's specimens from South Africa both labelled *A. falcatulum* C. Muell. were in fact different species. The specimen from Greenpoint, *Rehmann 429b* fits the descriptions of *A. julicaule* by Mueller (1899) and Roth (1911) reasonably well. The type of *A. julicaule* has not been examined and was probably destroyed at Berlin. One of the Victorian species, *A. clavatum* closely resembles this specimen, but the Victorian species differs in the truncate apex to many leaves and perichaetial leaves, and in the denticulations of the margin which are formed from one cell in the South African specimen and two in *A. clavatum*.

Sim (1926) states that *A. julicaule* " is exactly *Pleuridium nervosum* with few spores (12 to 20) instead of many ". The capsule, spores, and perichaetium are of course entirely different in the two mosses, a fact noted by Potier de la Varde (1958) and no doubt the anatomical structure of the stem and leaf would serve to separate the two in the sterile state, just as they do for the Victorian species.

ACKNOWLEDGEMENTS

I am greatly indebted to Mr. J. H. Willis, National Herbarium, Melbourne, for the Latin rendering of the diagnoses, and to Dr. H. J.

Swart, University of Melbourne, for translations of many of the German references.

I am grateful to the directors of the Sydney, Melbourne and Brisbane herbaria for providing me with access to their collections, and I wish to thank Professor T. C. Chambers, University of Melbourne, for helpful comments on the manuscript, and also Mr. A. G. Stone for the photographs.

I wish to thank the A.R.G.C. for a grant from which part of the expenses of travel was paid.

REFERENCES

Britton, Elizabeth G. (1913).—Archidiaceae. *North American Flora* 15: 45–6.

Brotherus, V. F. (1893).—Some new species of Australian mosses. *Öfversigt Förhandlingar Finska Vetenskaps-Societetens.* **35**: 35.

Brotherus, V. F. (1924).—Archidiaceae. *In* Engler, A., and Prantl, K., "Die natürlichen Pflanzenfamilien". 2 Aufl. Bd. **10**. (Engelmann: Leipzig).

Cain, A. S. (1936).—Archidiaceae. *In* Grout, A. J., "Moss Flora of North America". Vol. **1**. (Grout: Newfane, Vermont.)

Clifford, H. T., and Willis, J. H. (1951).—The genera of Victorian mosses and new records of species for the state of Victoria. *Victorian Naturalist* **68**: 151.

Davis, Gwenda (1966).—"Systematic Embryology of the Angiosperms". (Wiley & Sons Inc., N. York, London, Sydney).

Echlin, P. and Godwin, H. (1968).—The ultrastructure and ontogeny of pollen in *Helleborus foetidus* L. *J. Cell. Sci.* **3**: 161–174.

Heslop-Harrison, J. (1968).—Pollen wall development. *Science* **161**: 203–237.

Larson, D. A., and Lewis C. W. (1961).—Fine structure of *Parkinsonia aculeata* pollen. *Amer. J. Bot.* **48**: 934–943.

Maheshwari, P. (1950).—"An Introduction to the Embryology of Angiosperms". (McGraw Hill Book Co. Inc., N. York, Toronto, London).

McClymont, J. W. and Larson, D. A. (1964).—An electron-microscopic study of spore wall structure in the Musci. *Amer. J. Bot.* **51**: 195–200.

Mitten, W. (1887).—Mosses and Hepaticae collected in Central Africa. *J. Linn. Soc. Bot.* 22: 298–328.

Müller, C. (1882).—Musci cleistocarpi. *Linnaea* **43**: 343–9.

Müller, C. (1888).—Musci cleistocarpici novi. *Flora* **71**: 7–9.

Müller, C. (1899).—Contributiones ad Bryologiam austro-afram. *Hedwigia* **38**: 52–155.

Potier de la Varde, R. (1958).—Contribution à la flora bryologique africaine. *Rev. Bryol. et Lichenol.* **27**: 3.

Sim, T. R. (1926).—The Bryophyta of South Africa. *Trans Roy. Soc. S. Africa* **15**: 140–143.

Stone, Ilma G. (1961).—The gametophore and sporophyte of *Mittenia plumula* (Mitt.) Lindb. *Aust. J. Bot.* **9**: 124–151.

Roth, G. (1911).—"Die aussereuropäischen Laubmoose". Band **1**. (Heinrich: Dresden).

Roth, G. (1914).—Nachtrag 2 zu Band 1 der aussereuropäischen Laubmoose von 1910/11. *Hedwigia* **54**: 267–274.

GENERAL INDEX

VOLUME 2. (1969–1972)

Where the name of a taxon is merely mentioned in the text or cited in synonymy, then page numbers are in thinner type. Where an illustration appears in this volume, the name of the plant is followed by an asterisk (*).

C. H. Rixon, Government Printer, Melbourne.